PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference ---	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/PL 03/00117	International filing date *(day/month/year)* 12.11.2003	Priority date *(day/month/year)* 15.01.2003
International Patent Classification (IPC) or both national classification and IPC A63H33/04		
Applicant PIETRZYK, ANDRZEJ		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 7 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the opinion
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
06.08.2004	23.05.2005
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer Brumme, I Telephone No. +49 89 2399-7215

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/PL 03/00117

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

Description, Pages

7	as originally filed
1-6	received on 29.04.2005 with letter of 25.04.2005

Claims, Numbers

1-7	received on 29.04.2005 with letter of 25.04.2005

Drawings, Sheets

1/7-7/7	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).

   ☐ the language of publication of the international application (under Rule 48.3(b)).

   ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   ☐ contained in the international application in written form.

   ☐ filed together with the international application in computer readable form.

   ☐ furnished subsequently to this Authority in written form.

   ☐ furnished subsequently to this Authority in computer readable form.

   ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:

   ☐ the claims, Nos.:

   ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	
	No:	Claims	1-7
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-7
Industrial applicability (IA)	Yes:	Claims	1-7
	No:	Claims	

2. Citations and explanations

   see separate sheet

Re Item V

Reasoned statement under Article 35.2 PCT with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. STATE OF THE ART

Reference is made to the following documents (D) cited in the International Search Report. The numbering will be adhered to in the rest of the procedure:

D1: US-A-5 452 199 (MURATA SATOSHI) 19 September 1995 (1995-09-19)

D2: MURATA S ET AL: "Self-assembling machine" ROBOTICS AND AUTOMATION, 1994. PROCEEDINGS., 1994 IEEE INTERNATIONAL CONFERENCE ON SAN DIEGO, CA, USA 8-13 MAY 1994, LOS ALAMITOS, CA, USA,IEEE COMPUT. SOC, PAGE(S) 441-448 , XP010097674 ISBN: 0-8186-5330-2

D3: SOLEM J C: "Self-assembling micrites based on the Platonic solids" ROBOTICS AND AUTONOMOUS SYSTEMS, ELSEVIER SCIENCE PUBLISHERS, AMSTERDAM, NL, VOL. 38, NR. 2, PAGE(S) 69-92 , XP004339634 ISSN: 0921-8890

D4: US-A-6 157 872 (MICHAEL JOSEPH) 5 December 2000 (2000-12-05)

2. Independent claim 1

2.1 The solution proposed in the independent claim 1 of the present application does not fulfill the requirements of the *Article 33(2) PCT* for the following reasons:

2.2 The following features are already known from **D3**:

A system of three-dimensional multipurpose elements consisting of single solid elements (cf. pg.9 (pg.77 of the article) fig. 3 a and b) , which can move, connect one to and disconnect one from another, containing programable integrated circuits (cf. pg.16 (pg. 84 of the article) parag. 7 to pg. 20 (pg. 88 of the article) parag. 7.2 and fig. 9-15), electromagnets and interlocks for linking respectively said single elements (cf. pg. 9 (pg. 77 of the article) parag. 6, to pg. 23 (pg.91 of the article) para. 8), the system being characterised in that; every single element of the system has casing walls (see fig. 3b) having variable magnetic polarisation (cf. pg. 9 (pg. 77 of the article) parag. 6), the element has a voltage source inside, and every single element of the system

contains programme instructions (cf. pg.9 (pg.77 of the article) para. 6-6.3).

2.3 Therefore, since all the features defined by the independent **claim 1** have already been disclosed by **D3** this claim does not fulfill the requirements of *ARTICLE 33(2) PCT* in view of novelty.

3. The present application also does not meet the requirements of *ARTICLE 33(2) PCT* because the subject-matter of **claim 1** have already been disclosed by **D1** as follows:

3.1 The following physical features are already known from **D1**:

A system of three-dimensional multipurpose elements consisting of single solid elements (cf. col. 1, ln. 36-42 and fig. 2-4) , which can move (cf. col. 2, ln. 16-19), connect one to and disconnect one from another (cf. col. 1, ln. 54-68), containing programable integrated circuits (cf. col. 2, ln. 1-3 and col. 6, ln. 12-15), electromagnets and interlocks for linking respectively said single elements (cf. col. 3, ln. 23-45),

the system being characterised in that;

every single element of the system has casing walls having variable magnetic polarisation, the element has a voltage source inside (cf. col. 4, ln. 46-54), and every single element of the system contains programme instructions (cf. col. 3, ln. 46 to col. 4, ln. 5 and col. 5, ln. 17-27 and col. 6, ln. 10-26).

4. Independent method **claim 7.**

4.1 The subject-matter of **claim 7** does not meet the requirements of Article. 33(3) PCT) for the following reasons:

4.2 Document **D1** is regarded as being the closest prior art to the subject-matter of **claim 7**, and discloses:

A method for creating three dimensional constructions by connecting and disconnecting the three-dimensional multipurpose elements as a result of their reciprocal positions (cf. col. 3, ln. 46 to col. 4, ln. 5)

characterised by that,

the reciprocal position of single multipurpose elements is the result of change of electromagnetic polarisation of their casing walls and the change is realised by

activation or inactivation single elements of the system (cf. col. 3, ln. 46 to col. 4, ln. 5) and the information about a virtual object being connected are transmitted from an active single element of the system to the memory of the integrated circuit of the inactive single element of the system (cf. col. 6, ln. 10-26), and the integrated circuit decides on activation or deactivation of the respective walls of the single elements of the system to be linked successively (cf. col. 5, ln. 17-27).

4.3 The difference between the present independent **method claim 7** and the prior art Document **D1** lies essentially in the design of the program-code used to instruct the single three-dimensional multipurpose elements to form a particular shape. In this case *'assigning to each single element a successive running number'*.

4.4 Although **D1** does not specifically discloses the basic functioning of the program to such an in-depth level as the present application (cf, col. 5, ln. 17-27 and col. 6, ln. 10-269), it is however obvious to a person skilled in the art that this particular procedure (devising running numbers to each single element) is just one of many ways of instructing single elements to reach a particular coordinate in a particular shape. This is even more so obvious since the system of single elements disclosed in the cited prior art document **D3** is confronted with this exact problem of 'instructing single elements to reach a particular coordinate in a particular shape' and solves this problem by *'assigning to each single element a successive running number'* (cf. pg. 20 (pg. 88 of the article) parag. 7.2).

4.5 Hence, the program-code of *assigning to each single element a successive running numbers* controlling each of the single elements disclosed in the prior art document **D3** can be combined with the software disclosed in **D1** in order for any single individual element to reach any particular coordinate in a particular shape without the use of an inventing step.

4.6 Therefore the simple code wherein each element is assigned a *'running number'* in order for this to know where it stands in the formation is not considered as fulfilling the requirements of *ARTICLE 33(3) PCT* since this can be extracted from D3 and combined with the apparatus from D1 by a person skilled in the art, arriving at the exact subject mater as defined by the independent **claim 7**.

5. Dependent claims 2-6

5.1 Dependent **claims 2-6** do not contain any features which, in combination with the features of the claims to which they refer, meet the requirements of the PCT in respect of novelty *ARTICLE 33(2)*, or inventive step *ARTICLE 33(3)* the reasons being as follows:

The subject matter of the **claims 2-4** wherein the electromagnets are placed inside the single elements and the walls are reciprocal movable by means of electro plastic actuators and having a voltage source are already known from **D1 or D3** (cf. in D1 col. 3, ln. 46 to col. **4**, ln. 14) and (cf. in D3, pg. 2 (pg. 70 of the article) para. 2).

Hence these claims 2-4 do not fulfill the requirements of *ARTICLE 33(2) and (3)*.

The subject matter of the **claims 5-6** wherein the data of the program is transferred from one element to the other via fibre optic and the voltage source is provided by a battery charged by solar power is also known from **D1** (cf. col. 4, ln. 15-54).

Hence these claims 5-6 do not fulfill the requirements of *ARTICLE 33(2) AND (3)*.

Amended Description

A System of Three-Dimensional Multipurpose Elements and the method for creating three-dimensional Multipurpose Elements

Technical Field

The subject of the invention is a system of three – dimensional multipurpose elements and the method for creating three-dimensional Multipurpose Elements used for creating three-dimensional constructions, having a vast range of forms, colours and materials, mechanical, kinematics and functional properties, by making use of autonomously independent solid elements. According to the invention, the system of three-dimensional multipurpose elements may be applied, through making functional copies of the original, in various technologies, for example in space technologies, furniture industry, decorative and building industry, toy-making and entertainment industry, orthopaedics, three-dimensional mobile telephony, for manufacturing industrial, rescue and household robots, and finally, for generating research simulation systems, especially in genetics, crystallography and chemistry.

Background Art

The description of International patent application PCT/GB95/00460 (publication no WO 95/23676) reveals some programmable materials constituting a set of hexagonal bricks, named monomers, which can move towards each other in a computer-controlled mode and create structures and mechanisms. Monomers can both combine with other monomers and move towards each other unseparated. In case a monomer is damaged, those still in existence eliminate it and replace with a good clone. The motion of monomers is systematically split into streams, gates, trunk lines and containers for designating individual paths of motion of respective monomers necessary in the synthesis of the entire structure. Specialised monomers are provided with tools, which form the intended devices together with the intended and synthesised structure. Monomers have grooves in the vertical symmetry axes of the sidewalls; instead, inside monomers there are protrusive interlocks provided with sliding wedges. Neighbouring monomers may be combined and blocked with each other or linked in such a way that their reciprocal translocations upon connecting are possible through a toothed bar and a toothed wheel [s] or otherwise. Respective monomers maybe positioned with each other through a system of latches controlled either with an electromagnet or a linear induction motor. The second monomer form is provided with four symmetrical grooves on each wall, the grooves being

positioned at an angle of 45 ° to the wall symmetry axis. Those grooves serve for inserting elements, which block the mutual connection of neighbouring monomers. The third monomer form is provided with frontal elements on all six walls, the elements being supplied with tee section grooves placed in the symmetry axes of the elements. In the grooves are placed latch units, which allow aligning the reciprocal position of the monomers being linked. The latch units are controlled by gear transmissions arranged vertically to the external surface of the frontal elements of monomer. Linear induction motors with electromagnets secure the transport of monomers. The linear induction motors of stationary monomers translate the monomers, which are to be transported. A precise co-ordination of linear induction motors of the series of stationary monomers allows attaining a high transport velocity along that series. Electricity is supplied and the transmission of the controlling data occurs from the central source through neighbouring monomers.

The paper entitled „3-D Self-Assembling and Actuation of Electrostatic Microstructures" published in the „IEEE TRANSACTION ON ELECTRON DEVICES" VOL. 48, NO 8, AUGUST 2001 reveals a three - dimensional self-assembling and starting electrostatic microstructure. The purpose of the microstructure is completion of the dedicated controlling elements for optical applications, and especially, for micro-mirror matrices with large angels of reflection. The initial flat structure is performed inside one polysilicon structural layer. The mobile structure contains a rotating plate connected with two principal supporting beams through thin elastic props. Combinations of four integrated final control units SDA determine the supporting beams. Through a pulsating electric signal, SDA elements move and eventually bend the initially flat structural layer. Reached the required shape of the structure, the respective elements are mechanically blocked.

In addition, the publication „Self-Assembling Machine" (PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON ROBOTICS AND AUTOMATION, San Diego, MAY 8 – 13, 1994, LOS ALAMITOS, IEEE COMP. SOC. PRESS, US) reveals a self-assembling device consisting of identical elements completing a two-dimension machine. Each element is made up of three layers and has no mobile parts. The top and bottom layers have identical shapes and each contains three magnets arranged symmetrically, while their magnetic north pole is placed on the bottom layer. The middle layer has the same shape as the top and bottom ones, but is turned at an angle of 60 ° towards them and contains three electromagnets in lieu of magnets.

The electromagnets have the magnets retracted or pushed out according to the polarisation of the voltage applied and may rotate between two magnets without any

effect on the magnetic field. Each element may be linked to no more than other 6 elements. The communication between respective elements is secured due to an infrared optical system. The relays and receivers are arranged in the holes in the middle of the magnets and electromagnets. In the communication is applied an asynchronous series protocol. An 8-bit processor is to decide on the polarisation of the electromagnets in compliance with the information received. Electricity is provided in a wireless system where the plate on which the elements are arranged is used as supply terminal. The plate is divided into zones and every second of them is connected to the supply voltage, whereas the remaining ones are earthed. The elements are fed from four contacts and a rectifier. Respective elements have only information on local connections with the neighbouring elements. The shape of the entire structure is described basing upon local links between respective elements.

Disclosure of Invention

According to the invention, in the system of three-dimensional multipurpose elements, consisting of single solid elements, which can translocate, connect one to and disconnect one from another, containing programmable integrated circuits, interlocks for linking respective single elements and electromagnets, the casing walls of a single element of the system have magnetic polarisation depending on the programmed position of the single element in the real structure under formation. In the active state of a single element, the walls of the casing of a single element of the system have different magnetic polarisation, whereas in the inactive state of a single element, the walls of the casing of a single element of the system have identical magnetic polarisation. Upon connecting an active single element of the system to an inactive single element of the system, information about a virtual object and information about the successive running number in the real structure of the inactive single element of the system being connected is transmitted from an active single element of the system to the memory of the integrated circuit of the inactive single element of the system. Sets of co-ordinates of the walls of the casing of a given single element of the system are assigned to the running numbers of single elements of the system. The sets of those data are transferred to the program in the integrated circuit of each single element of the system, while the program in the integrated circuit is to decide on both activation or deactivation of the respective walls of single elements of the system and assigning a proper running number to a single element of the system to be linked successively.

Magnetic polarisation in the walls of the casing of a single element of the system is generated by electromagnets placed inside a single element of the system. The

walls of the casing of a single element of the system are connected to each other so that their reciprocal position can be changed. The walls of the casing of a single element of the system are connected with each other by means of electroplastic actuators, which control the reciprocal positioning of the walls according to the exciting signals transmitted from the programmable integrated circuit.

A single element of the system has a voltage source supplying the integrated circuit, interlocks, electromagnets and electroplastic actuators.

The voltage source is renewable due to supply from solar batteries. The light to the solar batteries is carried in light pipes which also carry both information on the object and program instructions to the integrated circuit .The real structure of the object may be dissipated to the initial state of single elements of the system through deactivation of all casing walls of single system elements and disconnection of all interlocks in consequence of transmitting information to the integrated circuit.

According to the invention, the system enables a multiple use of the same single elements of the system for making new structures having destroyed first the previous structure. Each of the single elements of the system has got a set of information necessary for reconstructing a real structure designed. From any quantity of single elements of the system one can create structures and constructions, designed according to one's wish, and having a vast range of forms, colours and materials, mechanical, kinematics, material and dynamic properties.

Brief Description of Drawings

The system of three-dimensional multipurpose elementsand the method for creating three-dimensional Multipurpose Elements and its function is explained in detail taking as example its version as in Fig. 1 presents an outlined structure of an active element of the system, Fig. 2 – an outlined structure of an inactive single element of the system, Fig. 3 – The initial phase of connection under execution of a single active element of the system with an inactive element of the system, Fig. 4 – the final phase of connection of an active single element of the system with an inactive single element of the system, Fig. 5 – an outlined permanent connection of five single elements of the system making the real structure, Fig. 6 – a picture of a real, three-dimensional structure made up of five single elements of the system, and finally, Fig. 7 shows a simplified view of a mobile container with single elements of the system placed in it.

Best Mode for Carrying Out the Invention

A single element of the system of three-dimensional multipurpose elements consists of a casing made up of walls 6 linked to each other by means of electroplastic actuators 3 which can change the reciprocal position of the walls 6 of the casing of a single element of the system of three-dimensional multipurpose elements through tensioning or slackening. Changes in the reciprocal position of the walls 6 occur according to the exciting signal transmitted from a programmable integrated circuit 1. Heat emitters 14 carry away both excess heat generated in the process of changes of reciprocal position of the walls 6 of the casing of a single element and the heat from other system devices. Inside a single element there are provided interlocks 7 for connecting respective single elements, magnetic coils 8 and a voltage DC source 5 supplying the integrated circuit 1, interlocks 7, magnetic coils 8 and electroplastic actuators 3.

The voltage source 5 is renewable due to supply from solar batteries 4. The light to the solar batteries is carried in light pipes 2, which also carry both informations on the object 10 and program instructions 12 to the integrated circuit 1.

In the inactive state, the single element of the system of three-dimensional multipurpose elements has all walls 6 of the casing polarised with identical [negative or positive] magnetic poles. In the active state, the respective walls 6 of the casing of a single element may be polarised with different magnetic poles. Polarisation on the respective walls 6 of the casing of a single element of the system depends on the position of the given element of the system in the real structure under creation 9 according to the virtual structure of the object 10 programmed in the integrated circuit 1. The set of inactive single elements of identical magnetic polarity, placed in the container 11 [Fig 7], is subject to a constant motion under control. As soon as an active single element of the system has appeared in the set of single inactive elements of the system, the nearest inactive element of the system is connected to the active element of the system. The first active single element of the system has the initial number 13 of the virtual structure of the object 10, marked 1, and corresponds to the same number in the real structure 9 under creation (Fig.6).

Upon connecting an active single element of the system to an inactive single element of the system, both an information on a virtual object 10 and an information on the successive running number 13 in the real structure 9 of the inactive single element of the system being connected is transmitted from an active single element of the system to the memory of the integrated circuit 1 of the inactive single element of the system, while sets of co-ordinates of the walls 6 of the casing of a given single element of the system are assigned to the running numbers 13 of single elements of the system, the sets of those data are transferred to the program 12 in the

integrated circuit 1 of each single element of the system. According to the data transmitted regarding the virtual object 10, the program 12 in the integrated circuit 1 is to decide on both activation or deactivation of the respective walls 6 of single elements of the system and assigning a proper running number 13 to a single element of the system to be linked successively. When the successive single element of the system is linked to the prior single element of the system the connection is blocked by means of interlocks 7 of any type. The procedure of linking and activating respective single elements of the system and making the real structure of the object 9 remains in course until all single elements of the system, within the range of all running numbers 13, available in the virtual object 10 in the integrated circuit 1 are connected. Completed all connections between single elements of the system, there appears the real structure 9 complying with the virtual object 10. The real structure 9 of the object can be dissipated to the initial state of the single elements of the system, viz. to a loose initial set of inactive single elements of the system. This occurs through deactivation of all walls 6 of the casings of single elements of the system and disconnection of all interlocks 7 in consequence of having transferred appropriate information to all integrated circuits 1 of the real structure 9. After such a deactivation, all single elements of the system of three-dimensional multipurpose elements may be re-used for making a new three-dimensional structure for any purpose desired.

Amended claims

1. The system of three-dimensional multipurpose elements consisting of single solid elements which can move, connect one to and disconnect one from another, containing programmable integrated circuits, interlocks and electromagnets, characterised by that every single element of the system has casing walls (6) having variable magnetic polarisation, the element has a voltage source (5) inside, and every single element of the system contains programme instructions.
2. The system according to claim 1, characterised by that the casing walls (6) are connected to each other so that their reciprocal position can be changed.
3. The system according to claim 1, characterised by that the casing walls (6) are connected to each other by means of electroplastic actuator (3) which is connected to the programmable integrated circuit (1).
4. The system according to claim 1, characterised by that the voltage source (5) is a renewable source.
5. The system according to claim 4, characterised by that the renewable voltage source (5) is renewable due to supply from solar batteries (4).
6. The system according to claim 5, characterised by that the light to the solar batteries (4) is carried in light pipes (2).
7. The method for creating three-dimensional constructions consisting in connecting and disconnecting of three – dimensional multipurpose elements as a result of their reciprocal positions characterised by that the reciprocal position of single multipurpose elements is the result of change of electromagnetic polarisation of their casing walls (6), and the change is realised by activation or inactivation single elements of the system, and the information about a virtual object and about the successive running number of the real structure of the inactive single element being connected are transmitted from an active single element of the system to the memory of the integrated circuit (1) of the inactive single element of the system, and the integrated circuit (1) decides on activation or deactivation of the respective walls (6) of the single elements of the system to be linked successively.